DEPARTMENT OF THE ARMY



PROGRAM MANAGER FOR CHEMICAL DEMILITARIZATION ABERDEEN PROVING GROUND, MARYLAND 21010-5401

HD

July 5, 2000

07-05-00 P03:56 IN CC

Tooele Chemical Agent Disposal Facility

PM-00545

SUBJECT:

Department of the Army, Office of the Assistant Secretary, Deputy Director of Army Safety, Investigation Board Report for the Tooele Chemical Agent Disposal Facility (TOCDF), Tooele, Utah concerning the May 8, 2000 Common Stack Alarm Occurrence

Mr. Dennis Downs
Utah Department of Environmental Quality
Division of Solid and Hazardous Waste
288 North 1460 West
P.O. Box 16690
Salt Lake City, Utah 84116-0690

Dear Mr. Downs:

The purpose of this correspondence is to provide the informal 15-6 Investigation by the Department of the Army, Office of the Assistant Secretary, Deputy Director of Army Safety, for the May 8, 2000 Common Stack Alarm at the Tooele Chemical Agent Disposal Facility (TOCDF), dated June 30, 2000.

The enclosed report addresses in detail the findings and recommendations from the investigation conducted between 11 and 18 May 2000 at the TOCDF.

Your technical point of contact in this matter is Mr. J. David Jackson at (435) 833-7438.

James F. Colburn

EG&G Defense Materials

*CERTIFICATION STATEMENT

() ()

Sincerely,

J, David Jackson

TOCDF Site Project Manager

CERTIFICATION STATEMENT

John Todd

Deseret Chemical Depot

Enclosure

Copies Furnished: w/o Encls

Joe Stang
Pete Davis
COL Bruce E. Pate
Harold Oliver
Mike Saupe
File

*I CERTIFY UNDER PENALTY OF LAW THAT THIS DOCUMENT AND ALL ATTACHMENTS WERE PREPARED UNDER MY DIRECTION OR SUPERVISION IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHER AND EVALUATE THE INFORMATION SUBMITTED. BASED ON MY INQUIRTY OF THE PERSON OR PERSONS WHO MANAGE THE SYSTEM, OR THOSE PERSONS DIRECTLY RESPONSIBLE FOR GATHERING THE INFORMATION, THE INFORMATION, THE INFORMATION SUBMITTED IS, TO THE BEST OF MY KNOWLEDGE AND BELIEF, TRUE, ACCURATE AND COMPLETE. I AM MARKE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT FOR KNOWLING VIOLATIONS.

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
INSTALLATIONS AND ENVIRONMENT
110 ARMY PENTAGON
WASHINGTON DC 20310-0110

JUN 3 0 2000

MEMORANDUM FOR DEPUTY ASSISTANT SECRETARY OF THE ARMY (CHEMICAL DEMILITARIZATION PROGRAM) PROGRAM MANAGER FOR CHEMICAL DEMILITARIZATION

SUBJECT: Investigation Board Report – Tooele Chemical Agent Disposal Facility (TOCDF), Tooele, Utah

The subject report concerning the May 8, 2000, common stack alarm occurrence at TOCDF is provided for your use and release in support of improving chemical agent disposal safety. The U.S. Army Safety Center is designated the custodian of record for this report and will address any future FOIA requests.

Request the Program Manager for Chemical Demilitarization (PMCD) provide this office and the Director of Amy Safety NLT August 4, 2000, the PMCD implementation plan used and actions taken in addressing the findings and recommendations of this report.

My point of contact is Mr. Gary W. Abrisz, 697-0440.

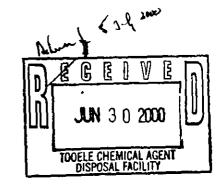
Raymond J. Fatz

Deputy Assistant Secretary of the Army (Environment, Safety and Occupational Health)
OASA(I&E)

Enclosure

cf: DACS-SF DAMO-SS

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INFORMAL 15-6 INVESTIGATION

OF THE

TOOELE CHEMICAL AGENT DISPOSAL FACILITY (TOCDF)

COMMON STACK RELEASE

8-9 MAY 2000

Investigating Officer:

KEVIN CONNORS

COL, IN

Deputy Director of Army Safety

EXECUTIVE SUMMARY

On the night of 8 May to 9 May 2000, nerve agent GB was detected at the Tooele Chemical Agent Disposal Facility (TOCDF) common stack on two separate occasions. The first occasion began at 2326 hours. The peak concentration during this event was 3.64 Allowable Stack Concentration (ASC). The second occasion began at 0028 hours. The final agent alarm cleared at 0056 hours. All the Deactivation Furnace System (DFS) duct and common stack alarms were confirmed by the analysis of the Depot Area Air Monitoring System (DAAMS) tubes.

On Tuesday, 9 May 2000, the decision was made to investigate this event. COL Kevin Connors, Deputy Director of Army Safety, assumed the role of 15-6 investigating officer on 11 May 2000. Technical advisors included personnel from the U.S. Army Nuclear and Chemical Agency (USANCA). U.S. Army Technical Center for Explosives Safety, Office of the Program Manager for Chemical Demilitarization (PMCD), Project Manager for Chemical Stockpile Disposal (PMCSD), Deseret Chemical Depot (DCD), and General Physics Corporation (GP):

Mr. James Walters
Mr. Kurt Clausen
Mr. Steve Blunk
Mr. Joe Stang
Mr. Rich Newton
Mr. Nick Stamatakis
Mr. Pete Davis
Mr. Lloyd Laycock
Mr. Andy Garcia
Mr. Craig Adams

USANCA, Chemical Safety
USATCES, Chemical Safety
PMCD, Chemical Engineer/Safety
PMCD, Environmental Compliance
PMCD, Environmental Monitoring
PMCD, Quality Assurance
PMCSD, Operations Team

DCD, Environmental DCD, Security GP, Process Controls

Two scientists, Dr. John Liddle and Mr. John Decker of the Centers for Disease Control and Prevention (CDC), partnered with the investigation team: the CDC report has been prepared and will be released separately from this report.

The investigation team determined that, due to an extraordinary sequence of events and circumstances, GB agent was emitted from the TOCDF common stack. Computer analysis indicated that there were no potential health effects to any human who was further than eight feet from the common stack; CDC has released a memo presenting preliminary findings that there was no impact to the health of TOCDF workers or the general public due to this accident.

The investigation determined the event was not caused by negligence or an intentional act. The investigation concluded that plant activities, human error, and equipment malfunction caused a DFS upset. The DFS upset caused excessively negative pressures and excessively high flue gas flow velocities in the DFS kiln, afterburner, and pollution abatement system that enabled agent vapors to be drawn into the DFS from the Explosives Containment Room (ECR) B and ultimately exhausted from the common stack.

The report makes recommendations intended to prevent recurrence in mechanical, procedural, and management areas.

REPORT OF PROCEEDINGS BY II	NVESTIGATING na AR 154: the propose		FICERS			
IF MORE SPACE IS REQUIRED IN FILLING OUT			ADDITIONAL SHEETS			
	TON I - APPOINTME					_
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Appointed by . Raymobil Face, Deputy Assistant Secretary of t	Mopointing		Оссирацопал неали			
	Adherent	шиногиуу				
on 9 May 2000 (Attach inclosure 1: Letter of appointm (Date)	uent or summary o	f oral appovimens data.) (:	See para 3-15, AR 15-6.)			_
SE SE	CTION II - SESSION	3				
The (investigation) (board) commenced at Tooele Chemical Agent		lity. Tooele, Utah		0730		
11 May 2000	(Place)			(Time)		•
on 11 May 2000 (If a formal board met for more than o ended, the place, persons present and absent, and explanation of absences,	ne session, check if any.) The follo	here 🔲 . Indicate in an ii wang persons (members, r	rclosure the time each sess espondents, counsel) were	ion befan C	and	
present: (After each name, indicate capacity, e.g., President, Recorder, Me COL Kevin Connors - Investigating Officer	ember, Legal Advi	sor.)				
Technical Advisors:			Ì			
Mr. James Walters - USANCA			<i>/</i> *			
Mr. Kurt Clasen - USATCES - Chemical Safety Mr. Steve Blunk - PMCD - Chem Eng/Safety			<i>!</i>			
Mr. Pete Davis - PMCSD - Operations Team						
Mr. Ioe Stang - PMCD - Environmental Compliance						j
Mr. Rich Newton - PMCD - Environmental Monitoring						
Mr. Nick Stamatakis - PMCD - Quality Assurance						ļ
Mr. Craig Adams - General Physics - Process Controls Mr. Lloyd Laycock - DCD - Environmental						
Mr. Andy Garcia - DCD - Security						
None					-	
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The (investigating officer) (board) finished gathering/hearing evidence at		1700	an18 M	fay 2000		
		(Time)		Date)		
and completed findings and recommendations at	1200	on _	6 June 200	<u>xo</u>		-
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A. COMPLETE IN ALL CASES				1 ES	NOS	1117
1 Inclosures (para 3-15, AR 15-6)	t	·		100	1 7	类扩
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a. The letter of appointment or a summary of oral appointment data?		_ _		- ^ -	}	HÔ.
b. Copy of nonce to respondent, if any? (See item 9, below)					├	X
c. Other correspondence with respondent or counsel, if any?					<u> </u>	X
d. All other written communications to or from the appointing authority?	<u></u>				}	X
e. Privacy Act Statements (Certificate, if statement provided orally)?					 	X
f. Explanation by the investigating officer or board of any unusual delay	s, difficulties, irm	guarines, or other probles	TLS.		1	×
encountered (e.g., absence of material witnesses)? g. Information as to sessions of a formal board are included on page 1 o	f this season?			-	 	₩
h. Any other eignificant papers (other than evidence) relating to admin		The Investment of the col	7	- -	 	X
FOOTNOTES: V Explain all negative answers on an attached sheet.	STARTS APPLES OF	me missokanni or nostu	<u>·</u>	X	!	
FOOTNOTES: A expecte of the MA column constitutes a positive representation that the	e dramatances des	ribed in the operation did not o	cour in this investigation			

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2	E-bby form LE AP IS 61			
1	Exhibits (para 3-16, AR 15-6)	YES	NO	NA2
	a. Are all items offered (whether or not received) or considered as evalence individually numbered or lettered as exhibits and attached to this report?	×		
	b. Is an index of all exhibits offered to or considered by investigating officer or board attached before the first exhibit?	1-		
	c. Has the testimony/statement of cach witness been recorded verbation or been reduced to written form and attached as	X		
	an exhibit?	1 1	X	
	d. Are copies, descriptions, or depictions (if substituted for real or documentary evidence) properly authenticated and is the location of the original evidence indicated?	×		
ĺ	e. Are descriptions or diagrams included of locations visited by the investigating officer or board (pare 3-60, AR 15-6)?	1×		
	f. Is each written supulation attached as an exhibit and is each oral supulation either reduced to writing and made an	1		-
	exhibit or recorded in a verbains record?		_	×
1	2. If official notice of any master was taken over the objection of a respondent or counsel, is a statement of the matter			
l	of which official notice was taken attached as an exhibit (para 3-16d, AR 15-6)?	1 1		X
厅	Was a quorum present when the board voted on findings and recommendations (paras 4-1 and 5-2b, AR 15-6)?	TX		\vdash
ᄫ	COMPLETE ONLY FOR FORMAL BOARD PROCEEDINGS (Chapter 5, AR 15-6)	100	AN	G38.5
4	At the initial session, did the recorder read, or determine that all participants had read, the letter of appointment (para 5-3b, AR 15-6)?	6152	- C 'C	
<u>۲</u>		1-1		33.32
5_	Was a quorum present at every session of the board (para 5-2b, AR 15-6)?			LA LA
6	Was each absence of any member property excused (para 5-Za, AR 15-6)?			
7	Were members, winnesses, reporter, and interpreter sworn, if required (para 3-1, AR 15-6)?			
8	If any members who voted on findings or recommendations were not present when the board received some evidence,	- 		-
_	does the inclusure describe how they familiarized themselves with that evidence (para 5-2d, AR 15-6)?			1
LC.	COMPLETE ONLY IF RESPONDENT WAS DESIGNATED (Section U. Chapter 5, AR 15-6)		-17	200
9	Notice to respondents (para 5-5, AR 15-6):		THE	*
1	a. Is the method and date of delivery to the respondent indicated on each letter of notification?	B 20 371 5	144.11	
	b. Was the date of delivery at least five working days prior to the first session of the board?			(d)()(f)
1	c. Does each letter of nonfermion indicate -	╁━╁		
	(1) the date, hour, and place of the first session of the board concerning that respondent?	╇		10.11
	(2) the matter to be investigated, including specific allegations against the respondent, if any?			
1	(3) the respondent's rights with regard to counsel?	1 -		Y 10
i	(4) the name and address of each winness expected to be called by the recorder?			Alamaya Marana
	(5) the respondent's rights to be present, present evidence, and call witnesses?	 		414.23
	d. Was the respondent provided a copy of all unclassified documents in the case file?	+		11:4
	e. If there were relevant classified materials, were the respondent and his counsel given access and an opportunity to examine them?	1-1		111031
10	If any respondent was designment after the proceedings began (or otherwise was absent during part of the proceedings);	N/65/5	स्टब्स	1000
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l	a. Was he properly notified (para 5-5, AR 15-6)?			
L	b. Was record of proceedings and evidence received in his absence made available for examination by him and his counsel (para 5-4c, AR 15-6)?			
11	Counsel (para 5-6, AR 15-6):	198	行登	1
1	a. Was each respondent represented by counsel?	\top	_	101.4
ł	Name and business address of counsel:	1,471		樓。
		(4)(4)	49 13	1011
l	(If counsel is a lawyer, check here 🔲)			111.00
	b. Was respondent's counsel present at all open sessions of the board relating to that respondent?	133.57	<u> </u>	
1				
	c. If military counsel was requested but not made available, is a copy (or, if oral, a summary) of the request and the action taken on it included in the report (para 5-6b, AR 15-6)?	1 !		
L	<u> </u>			
12	If the respondent challenged the legal advisor or any voting member for lack of impartiality (para 5-7, AR 15-6):			
	a. Was the challenge property dexied and by the appropriate officer?	1		
	b. Did each member successfully challenged cease to paracipan in the proceedings?	1		
13	Was the respondent given an opportunity to (para 5-8a, AR 15-6):	A) E		W. Rt
	a. Be present with his counsel at all open sessions of the board which deal with any matter which concerns that respondent?	- Anterior of	013110	12
	b. Examine and object to the introduction of real and documentary evidence, including written statements?			(Ergins fig.
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	C Object to the testimony of witnesses and cross-examine witnesses other than his own?			160
ŀ	d. Call witnesses and otherwise introduce evidence?	4		
	e. Testify as a witness?			
L	f. Make or have his counsel make a final statement or argument (pare 5-9, AR 15-6)?			特拉
14	If requested, did the recorder assist the respondent in obtaining evidence in possession of the Government and in	1		
ĺ	arranging for the presence of witnesses (para 5-8b, AR 15-6)?			
15	Are all of the respondent's requests and objections which were denied indicated in the report of proceedings or in an	\top		
	inclosure or exhibit to it (pare 5-11, AR 15-6)?			
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154	OTNOTES: U Explain all negative answers on an anached sheet.			1

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SECTION IV - FINDINGS (para 3-10, AR 15-6)	
The (investigating officer) (board), having carefully considered the evidence, finds: See Attached Narrative, consisting of 31 pages. Findings are interspersed with Recommendations. See below	
See Attached Narrative, consisting of 31 pages. Findings are interspersed with Recommendations. See below	v.
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SECTION V - RECOMMENDATIONS (para 3-11, AR 15-6)	
In view of the above findings, the (investigating officer) (board) recommends: See Findings and Recommendations, consisting of 7 pages.	
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SECTION VI - AUTHENTICATION (para 3-17, AR 15-6)		
THIS REPORT OF PROCEEDINGS IS COMPLETE AND ACCURATE. (If any voting member or the recorder fails to sign here or in Section VII vielow, indicate the reason in the space where his signature should appear.)		
CW3 Convers	COL Kevin Connors	
(Recorder)	(Investigating Officer) (President)	
(Member)	(Hember)	
(Member)	(Member)	
SECTION VII - MINORITY REPORT (Pagra 3-13, AR 15-6)	
To the extent indicated in Inclosure, the undersigned do(es) not con	neur in the findings and recommendations of the board.	
(In the inclosure, identify by number each finding and/or recommendation in which reasons for disagreement. Additional/substitute findings and/or recommendations in		
, ,	,	
	:	
(Member)	(Member)	
SECTION VIII - ACTION BY APPOINTING AUT	(HORITY (para 2-3, AR 15-6)	
The findings and recommendations of the (investigating officer) (board) are (app	proved) (disapproved) (approved with following exceptions/	
substitutions). (If the appointing authority returns the proceedings to the investigat corrective action, attach that correspondence (or a summary, if oral) as a number	ed inclosure.)	
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DEPARTMENT OF THE ARMY UNITED STATES ARMY SAFETT CENTER FORT RUCHER, ALABAMA 26262-9363

CSSC-JA 19 Jun 00

MEMORANDUM FOR RECORD

SUBJECT: Legal Review of the Investigation into the 8 May 2000 Common Stack Release at Tooele Chemical Agent Disposal Facility

- 1. I have reviewed the subject report and determined that it complies with requirements of AR 15-6. Sufficient evidence exists to support the findings by a preponderance of the evidence. The recommendations are consistent with the findings.
- 2. I note one error or omission but find that it is harmless. AR 15-6, para 3-7.c(5) states that direct testimony of witnesses is preferable. The report does not have direct testimony through sworn statements or transcripts. Rather, it has Exhibit M, a compilation of the evidence provided by multiple witnesses. It does not attribute any particular statement to any particular witness. Since AR 15-6 permits the investigating officer to consider previous statements on factual isspes, COL Connors was in his authority to capture the factual information garnered from the TOCDF employees and use it in the preparation of his report. Since the information garnered from TOCDF employees was obtained under the provisions of AR 385-40 promises of confidentiality, he did not include direct testimony in the report. This omission did not denigrate the sufficiency of the evidence to support the findings and recommendations.
- 3. No appointment order was prepared but a summary of the appointment instructions is provided in the 5 Jun 00 MFR contained in the report.
- 4. POC is the undersigned, DSN 558-2924.

SIGNED

CYNTHIA A. GLEISBERG LTC, JA Command Judge Advocate

INFORMAL 15-6 INVESTIGATION OF THE TOCDF COMMON STACK RELEASE, 8-9 MAY 2000

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INFORMAL 15-6 INVESTIGATION OF THE TOCDF COMMON STACK RELEASE, 8-9 MAY 2000

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EXHIBIT N: Photographs

- 1. M56 Warhead/M441 Shipping & Firing Tube
- 2. Ground Level View of TOCDF
- 3. DFS Kiln (UMCDF)
- 4. DFS Feed Chute (UMCDF)
- 5. Common Stack
- 6. Common Stack
- 7. DFS Afterburner .
- 8. Flue Gas Flow Meter (Installed)
- 9. Flue Gas Flow Meter Panel
- 10. Flue Gas Flow Meter Panel (Open)
- 11. Common Stack Monitoring House (Exterior)
- 12. Common Stack Monitoring House (Interior)
- 13. Common Stack Monitoring House (Interior)
- 14. ACAMS Unit
- 15. DAAMS Station

EXHIBIT O: CDC Letter - Expected Health Effects

EXHIBIT P: Process Data

EXHIBIT Q: TE-SOP-004 Approval Sheets

EXHIBIT R: DRAFT Occurrence Report, DFS Cyclone Bin Enclosure Incident of 30

April 2000, Extract

EXHIBIT S: Temporary Change DFS-0112

EXHIBIT T: Work Order # 00-0000061

INFORMAL 15-6 INVESTIGATION OF THE TOCDF COMMON STACK RELEASE, 8-9 MAY 2000

I. NARRATIVE

A. Background. The use of chemical weapons in World War I and the subsequent buildup of these chemical stockpiles by potentially hostile nations prompted the United States (U.S.) to develop and maintain its own chemical stockpile deterrent. In 1975, the U.S. ratified the 1925 Geneva Protocol, which prohibits the use of chemical weapons. Several nations, to include the United States, ratified the Treaty with a reservation that allowed retaliation in response to chemical use. Since U.S. ratification in 1975, the U.S. has continued to work for an international ban on manufacturing, stockpiling or using chemical weapons.

In 1985, Congress passed Public Law 99-145 initiating the Chemical Stockpile Disposal Program (CSDP) to eliminate the unitary chemical stockpile, starting with an emphasis on disposal of M55 rockets, a particularly hazardous munition. The program was expanded to treat the entire stockpile and led to the development of the current baseline incineration system. In 1992, after setting several intermediate goals and dates, Congress enacted Public Law 102-484 directing the Army to dispose of the entire unitary chemical warfare agent and munitions stockpile by 31 December 2004.

B. Facility Description. The Tooele Chemical Agent Disposal Facility (TOCDF) is located on Deseret Chemical Depot (DCD) (EXHIBIT F) in Tooele, Utah. The facility is designed to dispose of 44.5 percent of the nation's original stockpile of chemical weapons. TOCDF is the first chemical weapons disposal facility built within the continental U.S.

TOCDF incorporates systems originally tested and used at the Chemical Agent Munitions Disposal System (CAMDS), also located at the depot. These systems were first used on an industrial scale at the Army's Johnston Atoll Chemical Agent Disposal System (JACADS) in the Pacific Ocean. JACADS was the first integrated facility built to dispose of chemical weapons.

The contract to build and operate TOCDF was awarded to EG&G Defense Materials, Inc., of Wellesley, Massachusetts. Construction of the plant began in October 1989 under a subcontract to Morrison-Knudsen of Boise, Idaho. Disposal operations by EG&G, began in August 1996. Operations at TOCDF are scheduled to be completed in the year 2004. At that time, federal law requires the facility to be closed.

The facility staff and government personnel equal more than 700 employees during operations. Prior to working at the facility, operators undergo extensive specialized training at the Army's Chemical Demilitarization Training Facility (CDTF) at Aberdeen Proving Ground, Maryland. This training ensures that all workers have the skills and knowledge to safely operate and maintain the facility.

C. Event History.

Note: Various exhibits apply to the Event History. It is not always possible to associate a give statement with one exhibit. When an exhibit is directly referred to, it will be noted.

1. Pre Accident. The TOCDF was processing energetic M360 projectiles, non-energetic M360 projectiles, M56 warheads and M55 rockets. All of these munitions are GB filled. Due to a scheduled maintenance outage on the Liquid Incinerator (LIC) #2 and the Metal Parts Furnace (MPF), the facility had stopped the processing of all munition types except the M56 warheads. The facility had two of the four furnaces in operation. The Deactivation Furnace System (DFS) was processing the M56 warheads and the LIC # I was processing Spent Decontamination Solution (SDS). All other systems were operational and the facility was within the Limiting Conditions of Operation (LCO).

On 8 May 2000. C team, working the day shift, was processing M56 warheads in the DFS and SDS in LIC #1. Towards the end of the shift (at approximately 1600 hours) the lower tipping valve on the DFS was "sticking." (EXHIBIT AM) Processing was stopped to inspect and determine the cause of the problem. At approximately 1800 hours, A team relieved C team and the problem with the lower tipping valve was briefed to the oncoming shift. The A team DFS Control Room Operator (CRO) obtained a briefing on the DFS status and assumed control of the DFS. The DFS chute sprays were on at the time of the operator change.

An entry into the Explosive Containment Room (ECR) B was prepared to perform a water wash down of the DFS feed chute to correct the sticking lower tipping valve. The non-normal procedure used to perform the water wash down was briefed during the preentry meeting. The Entry CRO attended this meeting and handed a copy of the procedure to the DFS CRO.

The two-man entry into ECR B was performed in Demilitarization Protective Ensemble (DPE) level of dress. The entry was being controlled by the Entry CRO. The entrants entered the ECR at approximately 2010 hours and removed the protective shroud around the upper feed gate. The entrants then egressed the ECR. The DFS CRO established a negative pressure in the kiln in accordance with the Non-Normal Operating Procedure (NNOP) DFS-011-01. (EXHIBIT H) A NNOP is prepared at TOCDF to document the procedural steps, safety, environmental and special equipment requirements for operations and jobs that are performed on a one time or infrequent basis. The DFS CRO opened the upper feed gate and the lower tipping valve. The entrants reentered the ECR to inspect the lower tipping valve. At this time, the material causing the lower tipping valve to stick had already been dislodged. The entrants reported seeing the glow of burning embers at the bottom of the feed chute. The area around the lower tipping valve did, however, have some buildup of moist fiberglass and other powdery material. The entrants prepared to use the water lance to "power-wash" the debris. The hose failed due to a malfunctioning ball valve on the water line to the lance. The entrants egressed the ECR and the DFS CRO closed the lower tipping valve. The entrants replaced the ball valve to the water lance.

The DFS CRO reopened the lower tipping valve and the entrants returned to the ECR. The entrants attempted to use the droplight in the ECR to get a better view of the area to be cleaned. The droplight did not work. The entrants egressed the ECR and the DFS CRO closed the lower tipping valve. The entrants retrieved a droplight and the DFS CRO reopened the lower tipping valve and the entrants returned to the ECR. The entrants attempted to start the water to the lance and a hose clamp failed. The DFS CRO closed the lower tipping valve while the entrants obtained a spare and replaced the hose clamp. The DFS CRO reopened the lower tipping valve and the entrants returned to the ECR.

The entrants cleaned the debris from around the tipping valve using the water lance under the guidance of NNOP DFS-011-01. One entrant estimated that about 20 gailons of water was used. The entrants then performed a clean out of the Agent Quantification System (AQS) strainer and placed the strainer sock on the upper feed gate. The used sock contained about one pound of agent-contaminated fiberglass fragments. The entrants replaced the safety shroud around the upper feed gate and egressed the ECR B at 2141 hours.

During the entry into ECR B. the DFS CRO was attempting to maintain the DFS kiln at -1.5" Water Column (WC). The DFS feed chute sprays were also being used to reduce the temperature in the feed chute while entrants were in the ECR. The DFS kiln pressure controller, PIC-018, was set to maintain -1.5" WC as per the NNOP. The DFS CRO was receiving kiln low pressure alarms during the cycling of the upper feed gate and the lower tipping valve. The operator took manual control of the pressure controller and then returned the pressure controller to automatic to clear the kiln low pressure alarms. The DFS Afterburner (AFB) high flow alarm was also cycling due to the variations in the pressure and flue gas flow through the system. The DFS CRO attempted to stabilize the furnace pressure and flow through the use of the kiln pressure controller. PIC-018. The DFS CRO also noted a high current draw to the Induced Draft (ID) fans and attempted to stabilize the current by taking manual control of the kiln pressure controller and reducing the setpoint. The DFS CRO received and acknowledged a venturi scrubber high differential pressure alarm. The entrants exited the ECR and the DFS operator returned the kiln pressure controller to a setpoint of -0.5" WC. The DFS CRO then attempted to clear the venturi scrubber high differential pressure alarm by placing the venturi plug valve in manual.

During this time frame (2010 – 2158 hours), the kiln pressure was maintained consistently between –0.50" WC and –1.60" WC and the AFB pressure was maintained between –2.3" WC and -5.4" WC. System flow, pressure, and temperature responded to the opening and closing of the tipping valve and to the water wash-down of the DFS feed chute. (EXHIBIT P)

The DFS CRO attempted to control the system pressures and flows through the use of the venturi plug valve and the kiln pressure controller. The DFS CRO used the kiln pressure controller to clear the kiln low pressure alarm and the venturi plug valve to reduce the

high differential pressure across the venturi. The DFS CRO was able to clear the kiln low pressure alarm and began to open the venturi plug valve to reduce the high differential pressure and clear the alarm. The DFS CRO opened the venturi plug valve to 100%. The venturi plug valve operates at 60% under normal flow conditions.

The kiln and AFB pressure responded to the manipulations of the venturi scrubber differential pressure controller. The kiln pressure was controlled between -0.76" WC and -1.49" WC. The AFB pressure was maintained between -3.05" WC and -4.98" WC.

The DFS CRO received a scrubber tower packed bed low level alarm and opened the make-up valve to the packed bed in manual mode. The DFS CRO was able to clear the low level alarm. Then the DFS CRO received a flue gas flow meter alarm. This alarm caused a shutdown of the DFS kiln burner and AFB. The DFS CRO was being assisted by the Entry CRO and the acting Control Room Supervisor (SCRO). At the time of the flue gas flow meter failure and the subsequent burner lockouts, the kiln pressure controller was set to manual and the venturi scrubber differential pressure controller was operating in manual with a Control Variable (CV) of about 100%. The pressures were already trending to a more negative pressure. When the lockout occurred (at 2202 hours) both the AFB and kiln pressures immediately became more negative. The kiln and AFB pressures were indicating -2.00" WC and -6.00" WC, respectively, which is the lowest value the instruments are capable of recording. The Programmable Logic Controller (PLC) started a purge of the DFS AFB to allow a relight of the DFS AFB. Instrumentation Technicians (IT) began to troubleshoot the flue gas flow meter failure. During the purge of the DFS kiln and AFB, the flue gas flow meter was operating erratically. Also during the purge, the control system ramped open the combustion air flow control valves for the two AFB burners and the kiln burner. The control system also ramped open the kiln shroud air dampers. When this happened, the kiln pressure returned to -0.93" WC and the AFB pressure returned to -2.02" WC. The DFS CRO attempted to adjust the combustion air flows to both the kiln and the AFB. At this point, the CRO had taken manual control of the combustion air flow control valves for all three burners and reduced the CV to 10%. This was done to prevent cooling down the AFB while the Control Room (CON) was troubleshooting the failure of the flue gas flow meter. However, the venturi plug valve was still in manual with a CV of 100% and the kiln pressure controller was in manual with a CV of 20%. This configuration caused the kiln and AFB pressures to become excessively negative. The AFB pressure indicated -6.0" WC from 2205 until 2229 hours. The kiln pressure indicated between -1.46" WC and -2.00" WC during the same time frame.

At 2226 hours, the SCRO directed the DFS CRO to initiate a purge of the DFS and attempt to light at least one burner in the DFS AFB. The DFS CRO increased combustion air flow to the AFB in an attempt to purge the DFS. By 2248 hours, the SCRO made the decision to stop trying to purge the DFS due to continued intermittent failure of the flue gas flow meter. As of 2249 hours, the CRO had taken manual control of the combustion air flow controllers for all three burners and reduced the CV to 25%.

This was done to prevent cooling down the AFB while the CON was troubleshooting the failure of the flue gas flow meter. However, due to high system flue gas flow, the venturi scrubber differential pressure controller was operating with a CV of 100% even though it was set to automatic control. The kiln pressure controller was in manual with a CV of 15%. This configuration caused the kiln and AFB pressures to become excessively negative. The AFB pressure indicated -6.0 "WC from 2249 until 2336 hours. The kiln pressure indicated -2.00 "WC during the same time frame. The DFS kiln room pressure is normally maintained at -0.85" WC by the ventilation system. From 2320 until 2334 hours, the DFS kiln room pressure indicated -2.00" WC. In each case, the pressures became more negative than the instrumentation was calibrated to detect. Also during this time, the ECR B Automatic Continuous Air Monitoring System (ACAMS) readings dropped from about 0.32 to 0.01 Maximum Permissible Limit (MPL). At 2318 hours, the DFS CRO stopped the clean liquor pump. This was done in an attempt to assist in drving out the flue gas flow meter.

2. Accident. At 2326 hours the two common stack ACAMS units initially alarmed at 0.67 and 1.57 Allowable Stack Concentration (ASC), peaking at 3.64 and 3.39 ASC. Approximately 14 minutes later the DFS duct ACAMS alarmed at 1.45 ASC and the acting SCRO directed a bottle up of the DFS. The acting SCRO was informed that the Depot Area Air Monitoring System (DAAMS) tubes for the common stack and the DFS duct confirmed the presence of GB chemical agent. By 0023 the flue gas flow meter had been jumpered by the ITs and was now functioning. The acting SCRO directed the DFS CRO to attempt a second relight of the DFS AFB. The DFS AFB completed its purge and a relight was initiated. During the relight, the common stack and DFS duct ACAMS alarmed again. The acting SCRO directed a bottle up of the furnace.

The Army's downwind hazard prediction modeling program (D2PC) uses agent source level, ambient weather, and type of release to calculate conservative, safe-sided distances that the agent would expect to travel in hazardous levels. This hazard prediction software, which was used by DCD's emergency operations center personnel, estimated that the release from the common stack on the night of 8 May 2000 would have traveled less than eight feet from the stack. This represents the greatest distance at which a dosage potentially hazardous to the general public (No Significant Effects dosage) might be found. (EXHIBIT E)

3. Post Accident. The DFS kiln remains bottled up. A group of outside operators installed an isolation flange to isolate the DFS AFB from the DFS kiln. The DFS AFB is operating at normal operating temperature. An entry was made into ECR B to remove and decontaminate the AQS strainer sock that had been placed on the upper feed gate. The LIC #1 is idle and up to temperature. The MPF and LIC #2 remain shut down for scheduled maintenance. An M56 warhead remains on the Rocket Shear Machine (RSM) conveyor in ECR B.

II. ANALYSIS.

- A. Mechanical Systems Analysis. During the operation to control the DFS pressure and temperatures, the flue gas flow meter had become saturated by water giving a false low-low flow reading. The flue gas flow meter indicated that there was no flow through the system. However, other system instrumentation verified that there was significant tlue gas flow through the DFS. This shut down the DFS and AFB, increasing the problems with maintaining control of the system pressure and temperature. At approximately 2230 hours, a temporary change form, to allow engineering changes, was written by the acting SCRO to jumper (bypass) the flue gas flow meter (EXHIBIT S). Per Temporary Change Control Process for the Technical Baseline (Project Regulatory Procedure (PRP)-OP-009), five signatures are required for the temporary change before the work can be performed. Some of those individuals are not on site during all shifts On the night of the accident, initiation of the temporary change caused an approximate delay of 45 minutes before the approval was obtained. During this period of time, intermittent flue gas flow meter alarms delayed relight of the AFB burner. Relight of the AFB earlier in the event would have allowed the systems to be brought back to normal operations. This could have reduced the possibility of GB reaching the stack.
- 1. Burner Management System (BMS). The configuration of the burner management system does not allow for a restart of the furnace without conducting a purge of the system. The purge is required during normal starting of the furnace. During the sequence of events that led to the accident, the CRO had to purge the furnace in an attempt to relight the furnace. This purge allowed cold outside air to be drawn through the furnace, which reduced the temperature of the kiln and AFB. The burner management system had to complete the purge circuit. The purge circuit includes, among other conditions, an eight minute timer and high air flow rates as measured by the failed flue gas flow meter. At the time of the event, the furnace was above 1400°F and system flow was established, therefore there was no reason to purge the furnace prior to initiating a restart. During the second restart attempt the burner management system again required the furnace to complete the purge sequence. The BMS required purge of the system, which introduced cold air into the DFS system. This allowed GB agent to traverse through the system without complete destruction.
- 2. Flue Gas Flow Meter. At 2202 hours, 8 May 2000, the DFS flue gas flow meter failed. This meter is tied directly to the BMS for the DFS System. When the flue gas flow meter failed, the BMS locked out the kiln burner and both of the AFB burners.

After some initial troubleshooting of the flue gas flow meter, the DFS CRO initiated a system purge at 2226 hours. The DFS CRO was trying to light at least one AFB burner in order to maintain AFB chamber temperature above 1400°F. This temperature ensures complete destruction of combustible materials. The flue gas flow meter failed again during the system purge. This prohibited the DFS CRO from lighting any burners. By

2232 hours DFS AFB temperature had decreased to below 1500°F, the temperature required to relight the kiln burner.

Even though the CON was operating under the assumption that the kiln did not contain any chemical agent and, therefore, did not present any potential for release, they may have considered bottling up the DFS and isolating the DFS AFB from the kiln. The current method of isolating the DFS AFB from the kiln is for a team of outside operators to manually install a blind flange in the duct upstream of the DFS cyclone. Air is then allowed to flow to the DFS AFB from the bottom of the cyclone to make up for the lack of flow from the kiln. This is a very labor-intensive, time-consuming, and potentially hazardous operation. If the DFS AFB could have been isolated from the kiln remotely by the DFS CRO in the CON in a timely manner, then it is probable that the DFS CRO would have done so. If the DFS AFB had been isolated from the kiln during the attempts to troubleshoot the flue gas flow meter and relight one burner in the DFS AFB, there would have been no release of chemical agent from the common stack.

At the time of the flue gas flow meter failure and the subsequent burner lockouts, the kiln pressure controller was set to manual. The venturi scrubber differential pressure controller was also operating in manual with a CV of about 100%. The pressures were already trending toward a more negative pressure. When the lockout occurred, both the AFB and kiln pressures almost immediately became more negative than the pressure instrumentation is calibrated to detect. By 2202 hours the kiln and AFB pressures were indicating -2.00" WC and -6.00" WC, respectively.

On 1 January 2000, EG&G Maintenance Work Order #00-0000061 (EXHIBIT T) was written to investigate the cause of the malfunction and latching of flue gas flow meter low flow alarms, which had caused a burner lockout. Comments on this work order indicated that the malfunction was caused by moisture on the flow element probes. The malfunction cleared after flow through the system dried the probes.

According to EG&G Occurrence Report No: 00430-C! (Drait) (EXHIBIT R), the DFS flue gas flow meter failed during the DFS upset on 30 April 2000. The failure of the flue gas flow meter locked out the AFB burners and compounded the system upset. The report notes that the failure of the flue gas flow meter may have been caused by exposure to liquid during a period of high flow rates through the system.

At 2159 hours on 8 May 2000, the DFS CRO introduced make-up water to the DFS scrubber tower packed bed by opening the process water make-up valve in response to a low level alarm. At 2200 hours, the flue gas flow meter indicated a failure and generated a malfunction alarm. (EXHIBIT P)

The data indicate that the abnormally high flue gas flow through the system caused some carryover of the make-up water that was being introduced to the packed bed. This

carryover caused the flow elements in the flue gas flow meter to become saturated with liquid. The flow transmitter signaled a "trouble" alarm but was able to function for another 22 seconds. At 2230 hours, ITs indicated that the flue gas flow meter had been saturated with liquid and that it would not operate properly until it had time to dry.

If the flue gas flow meter had not been exposed to excessive amounts of liquid it would not have failed. If the flue gas flow meter had not failed, the DFS CRO would have been able to stabilize DFS flows and pressures. It is probable that the DFS CRO would have been able to return the DFS to its normal operating parameters and been able to process the contaminated AQS strainer sock safely. The investigation concluded that if the flue gas flow meter had not failed, there would have been no release of chemical agent from the common stack.

3. Programmable Logic Controller (PLC) Response to Loss of DFS Purge. The DFS BMS contains a timer unit and control circuitry that monitors the status of the DFS purge. When all of the DFS purge conditions are met, the timer unit begins to time out. During this time the system is said to be purging. Once the preset value of the timer is met, the system is said to be purged (i.e., DFS purge is complete). An indication that the system is purging and an indication that the system purge is complete are input into the PLC system that monitors and controls the DFS.

When flue gas flow meter failed, the BMS control circuitry de-energized the system purge timer unit. The indication that the purge was complete was no longer sent to the PLC that controls the DFS.

The DFS control software is currently designed to automatically purge the DFS system any time that the purge complete signal from the BMS is de-energized and the Pollution Abatement System (PAS) ID fans and DFS combustion air blowers are operating. To establish system purge, the PLC automatically increases the CV for the following controllers 1% CV per second to 100%.

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16-HIC-016 - Kiln Shroud Air
16-HIC-017 - Kiln Shroud Air
16-FIC-021 - Kiln Combustion Air
16-FIC-078 - AFB Burner #1 Combustion Air
16-FIC-079 - AFB Burner #2 Combustion Air
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At 2204 hours, the DFS CRO had to take manual control of the combustion air flow control valves for all three burners and reduced the CV to 10%. This was done to prevent cooling down the AFB while the CON was troubleshooting the failure of the flue gas flow meter.

On the night of the accident, the automatic purge by the DFS PLC had several negative affects on the response to the DFS system upset. It introduced a large amount of cool air

into the system, causing a rapid cooling of the kiln and AFB chambers. This situation distracted the DFS CRO from performing other recovery procedures. The sudden increase and subsequent decrease of large amounts of cold air flowing into the system compounded the DFS pressure control difficulties that already existed.

The investigation concluded that the automatic system response to detecting the loss of the signal that system purge is complete contributed to the difficulties during the recovery response to the DFS upset.

4. Afterburner Temperature Controller Response to Loss of Purge. The AFB temperature controller controls the firing rate of both of the AFB burners. When the system is operating automatically under normal conditions, the AFB temperature controller CV is used to control the fuel gas flow to each of the AFB burners.

When the AFB temperature controller is operating automatically, it compares the measured AFB temperature to the controller set point. If the AFB temperature is below the set point, the AFB temperature controller CV increases, thereby increasing the fuel gas flow rate to both burners. If the AFB temperature is above the set point, the AFB temperature controller CV decreases, thereby decreasing the fuel gas flow rate to both burners.

In the current design of the DFS PLC control software, the AFB temperature controller will operate in this fashion any time after either burner has been lit for more than thirty minutes or if the AFB chamber temperature is above 500°F. When the AFB burners trip, the temperature in the chamber decreases substantially, but not below 500°F. The AFB temperature controller automatically responds to the decrease in temperature by increasing the AFB temperature controller CV to 100%. If an AFB burner is relit when the AFB temperature controller CV is 100%, the burner fuel gas flow control valve would be controlled to the fully open position. This would cause an excessive amount of fuel gas to be introduced to the system. This rapid introduction of fuel gas to the burner may cause the burner to be shut down again. Therefore, DFS operators are trained to take manual control of the AFB temperature controller CV under upset conditions.

When the burners locked out, the temperature in the AFB chamber decreased rapidly; therefore, the AFB temperature controller CV increased to 100%. At 2203 hours, the DFS CRO placed the AFB temperature controller in manual and reduced the CV from 100% to 10%. The automatic response of the control system distracted the DFS CRO from performing other recovery procedures. The investigation concluded that if the DFS CRO had allowed the automatic response to continue, the AFB temperature controller would have contributed to the DFS upset.

B. Operations/Procedures Analysis

- 1. Environmental Compliance. On 8 May 2000 at 2326 hours, ACAMS 701C alarmed in the common stack and peaked at 3.64 ASC. Also at 2327 hours, ACAMS 701A alarmed and peaked at 3.39 ASC. Both ACAMS readings were confirmed by DAAMS. This is a non-compliance with the TOCDF Resource Conservation Recovery Act (RCRA) Permit. Module 5. Condition V.C.2.F. The facility is required under TOCDF RCRA Permit. Module 5. Condition 1.U., and Condition 1.U.1.d., to notify the State of Utah within 24 hours of a common stack agent release above 1 ASC. Proper notification was made. Additionally, TOCDF RCRA Permit, Module 1. Condition 1.U.5.b. requires written confirmation of the 24-hour notification within five days of the initial notification. This was accomplished on 11 May 2000.
- 2. <u>Non-Normal Operating Procedures (NNOPs)</u>. NNOPs are used, in accordance with PRP specifically, Non-Normal Development, Revision and Deletion, PRP-MG-010 (EXHIBIT I), for nonrecurring activities. The PRP, paragraph 6.5.2, requires that a NNOP be converted to a Standing Operating Procedure (SOP) if it is to be used repetitively. This statement is not definitive enough to effectively control the process, however; chute cleanouts have occurred at least twice in the previous three months. The intent of the NNOP process has been described as a largely informal method to handle short-fuse situations like test programs.

Cleanout of the DFS feed chute from ECR B, 8 May 2000, was being conducted using NNOP, DFS-011-01 (EXHIBIT H). PRP-MG-010 indicates that after thirty days the NNOP is automatically deleted unless an extension is granted. DFS-011-01 was approved 27 April 2000. The following comments apply specifically to DFS-011-01, the NNOP which was in use 8 May 2000:

- (a) The checklist procedure instructs the CON Engineer to clear interlocks to allow the upper feed gate and the ECR door to be open at the same time. However, it does not include any instruction to override the interlock which prevents the lower tipping valve and the upper feed gate from being open simultaneously. In fact, the attached safety evaluation notes as a recommended mitigating action (5.2) that the lower tipping valve remain closed when personnel are in the ECR. Interview statements were made that glowing material was seen below the transition section, and the entry was being made in order to clear a lower tipping valve that was stuck open. This indicated that both gates must have been open simultaneously when people were in the ECR.
- (b) The checklist procedure is not always clear about who is to perform a given task. As an example: Step 7 says, "CONNECT the hose and lance to a Process Water line." This must be accomplished by the entrants to the room. Step 9 says, "CLOSE the slide gate (MMS-GATE-103) and CYCLE the tipping gate (DFS-GATE-101)." This must be accomplished by the CON operator.

- (c) All references in the checklist procedure are to ECR A and tag numbers for equipment items in ECR A, but the entry was to ECR B.
- (d) The checklist procedure does not describe where the process water line to be tapped is located. It does not mention the ball valve, where the hose is connected to a process water line, which the entrants had to replace on this entry. The statement at Step 3, "Entrants must comply with the appropriate SOPs" lacks sufficient information to be meaningful. An SOP which would have been appropriate is TE-SOP-109, "Toxic MDB Entries."
- (e) The safety evaluation attached to the DFS-011-01 is not specific to this revision of the checklist procedure. The safety evaluation notes potential hazards associated with inspection by Closed Circuit Television (CCTV) at procedure steps 6 and 13. DFS-011-01 does not include steps for inspection with CCTV.
- (f) PRP-MG-010, paragraph 5.5, states that Safety will perform a safety hazards analysis to assure all risks have been mitigated and appropriate warnings and cautions included. Although the safety evaluation attached to DFS-011-01 uses the form specified in the PRP, it is not clear how the information presented accomplishes the goal set forth by paragraph 5.5. Specifically, neither the risk before mitigation nor the residual risk after mitigation have been identified or assessed. This is usually done through the use of a Risk Assessment Code (RAC). Use of RACs and an associated authority matrix assures that the risk of performing the operation is accepted at the appropriate level.
- (g) The safety evaluation does not identify any hazards associated with chemical agent. During the time of the first entry to ECR B by DPE-clad personnel of A Team on 8 May 2000, there was a significant amount of agent in the room air. It was stated that since the NNOP was written for activities in ECR A, where agent levels are minimal because of the operations which have been performed (fuze and burster removal from GB-filled M360 projectiles), agent exposure was not an issue.
- (h) The safety evaluation identifies hazards which are not usually associated with "safety." These include a RCRA violation and a poor TV picture. For overall management of an operation, it may be desirable to address these risks at the same time and in the same format as the more typical "safety" risks. It isn't immediately obvious, however, how such items should be coded to assure comparable assessment of risk.
- (i) The comments of the safety evaluation related to Step 2 of DFS-011-01 make it appear that a memo. Operations Management Memorandum (OMM)-00-05, provides considerably more instruction than would appear to be the case based on Step 2 of the checklist procedure. The potential hazard identified and the recommended action seem unclear, as well. The potential hazard is that adjusting the set point of TIC-182 may cause the Heated Discharge Conveyor (HDC) to lose temperature, resulting in a RCRA

violation. The recommended action, however, is that adjusting this set point will cause the kiln temperature to increase, thereby avoiding a RCRA violation. It appears that the same action (adjusting the set point of TIC-182) both poses and mitigates the same hazard.

- (j) Both the checklist procedure and the safety evaluation appear to presume the water lance will be operated by an individual standing above the feed gate. In fact, the safety evaluation, Step 9 (which actually corresponds to Step 7 of the checklist procedure, see item e, above) recommends that a water valve be connected directly to the water lance to be opened and closed from inside the ECR. Based on observation of the videotape documenting the entry on 8 May 2000, it appears the water flow was being controlled from outside the ECR in the Upper Munitions Corridor (UMC).
- (k) The entire instructions for the DFS operator with respect to controlling the furnace during this operation are given in a single step. Step 2, of the NNOP, "REDUCE the DFS kiln pressure in accordance with OMM-00-05." However, there is no discussion regarding how this is to be accomplished.

Army Regulation (AR) 385-61, Army Chemical Safety Program, paragraph 2-4.e, dated 28 February 1997, requires that operating procedures specify the steps to be taken in detail, and NNOP DFS-011-01 does not specify, in detail, the steps to be taken by either the DFS operator or the entrants to the ECR. Also of concern, the accuracy and validity of the risk assessment depend very heavily on the procedure being assessed. If the procedure does not identify steps, which will be taken, specifies them incorrectly, or assumes a very different operational environment than the one, which will actually be encountered, the conclusions of a risk assessment based on that procedure will be invalid.

Department of the Army Pamphlet (DA Pam), Toxic Chemical Agent Safety Standards, paragraph 6.3.a. dated 31 March 1997, requires that nazards for operations involving chemical agents be assigned a RAC. As noted above (paragraph f), the procedure for preparation of safety evaluations for NNOPs does not require or support the assignment of RACs. As such, risk information provided to decision makers is limited, and since residual risk is not identified, there is no guarantee it has been appropriately accepted.

TOCDF has an extensive and formal program for training, qualification, and certification of personnel using SOPs. Operators must read, understand and comply with SOP contents. SOPs are validated before being implemented. No such programs exist for NNOPs. The NNOP was reviewed during the DPE pre-entry meeting. Others who did not attend the pre-entry meeting (such as the DFS CRO) were handed the procedure immediately before being directed to implement it.

3. Clean Liquor Pump Operations. The DFS kiln pressure is normally maintained at -0.50" WC relative to the DFS kiln room. The DFS AFB pressure is normally maintained at about -2.30" WC relative to atmosphere. By 2249 hours on 8 May 2000,

the DFS upset had caused the kiln and AFB pressures to become excessively more negative than the pressure instrumentation is calibrated to detect. The AFB pressure indicated -6.0" WC from 2249 until 2336 hours. The kiln pressure indicated -2.00" WC during the same time frame.

The kiln room pressure is normally maintained at -0.85" WC by the ventilation system. During the time that the kiln pressure became very negative, the kiln room pressure also decreased. By 2322 hours, the kiln room pressure indicator was indicating more negative than the pressure instrumentation is calibrated to detect at -2.00" WC and remained at -2.00" WC until about 2338 hours.

Also during this time, the ECR B ACAMS readings dropped from about 0.32 to 0.01 MPL. This data indicates that when the kiln pressure became excessively negative, agent was drawn into the kiln from ECR B.

At 2318 hours, the DFS CRO manually stopped the operating clean liquor pump in an attempt to minimize the carryover of liquid to the flue gas flow meter. The clean liquor pump circulates high pH clean liquor onto the pall rings in the scrubber tower packed bed. This is done to ensure that the DFS flue gases have an increased contact time with the high pH clean liquor. When the clean liquor pump was stopped, the circulation of high pH clean liquor onto the pall rings stopped.

At 2326 hours, the common stack agent alarm (701C) activated. The PAS is designed to remove acid gases from incinerator exhaust and is not designed or intended to destroy chemical agent; however, the alkalinity of the solution will react with GB, if present. If the clean liquor flow had not been stopped, the agent in the DFS flue gas would have had increased contact time with the caustic in the clean liquor solution. The investigation concluded that if the clean liquor pump had remained running, the total amount of agent released from the common stack would have been reduced.

- 4. High Velocity of DFS Flue Gas. Events that occurred during and after the execution of a NNOP to wash debris from the DFS lower upping valve led to a situation in which the DFS furnace pressure was excessively negative and the flue gas velocity was excessively high. As discussed previously, agent was drawn into the kiln from ECR B. The high flue gas velocity helped to cool the kiln and AFB chamber. By 2326 hours, the kiln and AFB temperatures were 213°F and 1281°F, respectively. The thermal destruction of agent is dependent on temperature and residence time. The chemical neutralization of agent is dependent on pH and contact time. In either method, the high velocity of the flue gases decreased the agent destruction efficiency. The investigation concluded that the high velocity of the flue gases contributed to the release of chemical agent out of the common stack.
- 5. Excessive Water in the DFS Feed Chute. From 2125 to 2129 hours on 8 May 2000, approximately 100 gallons of process water, derived from Process Data Acquisition and

Recording System (PDARS) data, was introduced to the DFS feed chute during the execution of NNOP DFS 011-01 to wash debris from the DFS lower tipping valve. The kiln exhaust temperature decreased from 1022°F to 857°F due to the water being introduced and the cool room air being drawn in through the open feed gates. From 2034 to 2129 hours, the burner temperature increased from 1434°F to 1514°F in an attempt to maintain kiln exhaust temperature. The AFB temperature controller was also responding and increasing the burner firing rate to recover temperature to the set point.

The burner response to this addition of process water contributed to the DFS upset because the burners introduced additional fuel gas and combustion air into the system to maintain furnace temperature. The investigation concluded that the water that was added flashed to steam when it entered the high temperature environment of the kiln. This rapid generation of steam instantly upset the temperature/pressure relationship and contributed to the perturbations of the DFS pressures and flow rates.

6. DFS Pressure Control. There are two variable controlled devices in the DFS PAS that can be adjusted to modulate the restriction of flue gas flow through the DFS PAS. The first device is the plug valve in the DFS PAS venturi scrubber. This device can be raised into the venturi to restrict flow or lowered out of the venturi to reduce the impedance of flow. The second device is a variable damper located at the inlet of the DFS PAS ID fan. This device can be modulated open to allow flow to the ID fan with less differential pressure, or it can be modulated closed to restrict the flow of flue gas to the ID fan.

The TOCDF control system uses Proportional, Integral, and Derivative (PID) controllers to modulate variable controlled devices. The PID controller compares the controller Set Point (SP) to the measured Process Variable (PV). If the SP and PV are equal, then the CV remains unchanged. If the SP and PV are not equal, the PID controller changes the value of the CV to try to get the PV to match the SP.

The PID controller 24-PDIC-008 CV controls the position of the plug valve in the DFS PAS venturi scrubber. The PID controller, 16-PIC-018, controls the position of the variable damper located at the inlet of the DFS PAS ID fan.

The differential pressure across the venturi scrubber is controlled by 24-PDIC-008. If the differential pressure is too low (i.e., 20" WC) then hazardous waste feed to the DFS is stopped because the removal efficiency of the venturi scrubber can no longer be assured. When operating in the automatic mode, 24-PDIC-008 monitors the differential pressure across the venturi scrubber. If the differential pressure (i.e., the PV) decreases below the SP, 24-PDIC-008 CV decreases to modulate the plug valve into the venturi to restrict flow and increase differential pressure. If the PV increases above the SP, 24-PDIC-008 CV increases to modulate the plug valve out of the venturi in order to decrease the differential pressure. Typically, the 24-PDIC-008 SP is set to 30" WC.

The pressure inside the DFS kiln is controlled by 16-PIC-018. If the kiln pressure is too high (i.e., -0.1" WC) then hazardous waste feed to the DFS is stopped because there is not enough negative pressure to assure that there is no leakage from the kiln into the kiln room. When operating in the automatic mode, 16-PIC-018 monitors the pressure inside the kiln. If the kiln pressure (i.e., the PV) decreases below the SP, 16-PIC-018 CV decreases to modulate the ID fan inlet damper closed to restrict flow and therefore, increase kiln pressure. If the PV increases above the SP, 16-PIC-018 CV increases to modulate the ID fan inlet damper open to reduce the resistance to flow and therefore, decrease kiln pressure. Typically, the 16-PIC-018 SP is set to -0.50" WC.

Variable controlled devices typically operate most effectively when they are controlled between 25% and 75% CV. Below 25% and above 75% usually indicates non-linear system response.

From 2146 to 2150 hours, the DFS CRO gradually changed 24-PDIC-008 CV from 95% to 65% in the manual mode. The DFS CRO then placed 24-PDIC-008 in automatic mode.

From 2150 to 2158 hours, the kiln pressure was maintained between -0.68" WC and -1.49" WC. The AFB pressure was maintained between -3.05" WC and -4.98" WC. Both chamber pressures were becoming more negative because 24-PDIC-008 CV was increasing and 16-PIC-018 was in automatic but with a CV of less than 25%.

At 2158 hours, the DFS CRO gradually changed 24-PDIC-008 CV from 86% to 100% in the manual mode (note that the controller had increased the CV from 65% to 86% in about eight minutes because the differential pressure was above the SP).

From 2158 to 2202 hours. (just prior to the failure of the flue gas flow meter) the kiln pressure was maintained between -1.60" WC and -2.00" WC. The AFB pressure was maintained between -5.34" WC and -6.00" WC. Both chamber pressures were becoming more negative because 24-PDIC-008 CV was set at 100% and 16-PIC-018 was in manual with a CV of less than 25%.

At 2202 hours on 8 May 2000, the DFS flue gas flow meter failed. This caused an actuation of the "NFPA Loss of System Draft" alarm. This indication is tied directly to the BMS for the DFS system. When the alarm activated, the BMS locked out the kiln burner and both of the AFB burners.

At the time of the flue gas flow meter failure and the subsequent burner lockouts, the kiln pressure controller was set to manual. The venturi scrubber differential pressure controller was operating in manual with a CV of about 100%. The pressures were already trending to a more negative pressure. When the lockout occurred, both the AFB and kiln pressures immediately became more negative than the pressure instrumentation

is calibrated to detect. By 2203 hours, the kiln and AFB pressures were indicating -2.00" WC and -6.00" WC, respectively.

At 2204 hours, the DFS CRO had to take manual control of the combustion air flow control valves for all three burners and reduced the CV to 10%. This was done to prevent cooling down the AFB while the CON was troubleshooting the failure of the flue gas tlow meter.

The DFS CRO was still controlling 24-PDIC-008 in manual with a CV of 100% and 16-PIC-018 was in manual with a CV of 20%. This configuration caused the kiln and AFB pressures to become excessively negative. The AFB pressure indicated -6.0" WC from 2205 until 2229 hours. The kiln pressure indicated between -1.46" WC and -2.00" WC during the same time frame. The data indicate that when the kiln pressure became excessively negative, agent was drawn into the kiln from ECR B.

The investigation concluded that the inability of the DFS CRO to maintain DFS system pressures adequately after the execution of the NNOP DFS 011-01 to clean debris from the DFS lower tipping valve was a contributing factor to the release of chemical agent out of the common stack.

- 7. Demilitarization Protective Ensemble (DPE) Entry. The DPE entry had been planned to accomplish two things: (1) The DFS feed chute was to be cleaned and (2.) Preventive Maintenance (PM) for the RSM was to be accomplished. Although time did not allow both tasks to be completed, the feed chute was cleaned and the strainer sock (removable/disposable filter bag) was changed. During the process to change out the sock, an entrant's airline was stretched above the upper feed gate, which was hot. This is the upper feed gate for the DFS feed chute, but it is at floor level in the ECR. Although failure of the airline would not be expected to have immediate catastrophic results for the entrant, the entrant's breathing air supply would immediately be limited to the 8-10 minute bottle on the DPE back pack. This bottle would provide more than sufficient air for the entrant to hastily egress through the nearest emergency exit.
- 8. Standing Operating Procedure (SOP) Organization. The organization of SOPs can make timely retrieval of information, especially under the adverse circumstances of a plant upset, very difficult. To discover how to recover from an upset, an operator may be required to flip through pages to a section on Contingency Startup, only to be directed to flip back through more pages to Normal Startup. This takes time, which could more profitably be spent recovering from the upset, as well as adds to the general confusion of an already confused situation. This added confusion and increased time prevents the operator from reacting quickly to correct upset conditions.

The SOP for the DFS Furnace System Operation (SOP-004) does not include procedures for restart of the DFS AFB after a burner lockout. The procedure allows for only two options during an upset condition, (1) the bottle up of the DFS or (2) perform an

emergency shut down. The procedure does not outline the steps necessary to recover just the DFS AFB and return the AFB to normal operation. The operator must restart the furnace following the normal system start up. The SOP also lacks the detailed actions to be taken if the expected outcome is not achieved. In contrast, the LIC SOPs allow for a restart of the furnace after an upset condition. If the DFS SOP had contained detailed procedures to restart the DFS furnace during the conditions experienced, this accident would not have occurred.

The CRO attempted to use an uncontrolled copy of the BMS schematics to assist in the trouble shooting of the failed flue gas flow meter. The CROs routinely make copies of the system schematics that affect the systems they are controlling. This practice is in violation of PRP-DC-008 section 4.13. These uncontrolled copies are located next to the console for easy reference during operations. The schematics are not part of the management system that ensures only controlled copies are in use. This allows the CRO to use schematics that may not be current. The investigation concluded that the use of uncontrolled schematics is a dangerous practice.

9. Monitoring Data. The ACAMS and the DAAMS worked as they were supposed to, alerting the workers at the TOCDF to the presence of the chemical agent, GB. The ACAMS and DAAMS equipment functioned properly and personnel from the Laboratory and Monitoring Branch responded with the appropriate action. A thorough analysis of the ACAMS and DAAMS data was performed during this investigation. The analysis verified that the proper Laboratory Operating Procedure (LOP) was in use and was fully adhered to. There were no problems with the calibration, data analysis, or reporting of the results for either the ACAMS or the DAAMS. However, a mix up of the DAAMS paperwork during the chemical event may have diverted resources in the TOCDF CON for a period of approximately ten minutes.

The ACAMS involved in the event are 701A, 701B, 701C, and 702. ACAMS 701A, B. and C are located near the top of the common stack and ACAMS 702 is located in the duct coming from the DFS PAS going to the common stack. The DAAMS involved in the event have the same identifying alphanumeric code.

A time line of ACAMS alarms received during the event is presented below (NOTE: Only the time of initial alarm and the time the alarm cleared is presented in this abbreviated timeline):

8 May 2000

2326 hours - ACAMS alarm sounded at 701C, 0.67 ASC

2328 hours - ACAMS alarm sounded at 701A, 1.57 ASC

2341 hours - ACAMS alarm sounded at 702, 1.45 ASC

2351 hours - ACAMS alarm clears at 701A

2353 hours - ACAMS alarm clears at 701C

9 May 2000

0008 hours - ACAMS alarm clears at 702

0028 hours - ACAMS alarm sounded at 702, 0.87 ASC

0028 hours - ACAMS alarm sounded at 701B, 0.39 ASC

0029 hours - ACAMS alarm sounded at 701C, 0.56 ASC

0038 hours - ACAMS alarm clears at 701C

0040 hours - ACAMS alarm clears at 701B

0056 hours - ACAMS alarm clears at 702

Calibration and Quality Control (QC) data were reviewed during this investigation to ensure ACAMS 701A, 701B, 701C and 702 were properly maintained. Based on review of this data, the ACAMS were properly maintained. ACAMS 701A, 701B, and 701C required QC every four hours. This is a part of the normal maintenance and QC schedule. The PDARS data shows ACAMS 701A, 701B, and 701C had proper QC both before and after the accident. Moreover, this QC demonstrated ACAMS 701A, 701B, and 701C were operating correctly. ACAMS 702 has slightly less rigorous requirements since it is a less critical alarm, but QC was performed within 24 hours of the event, as required. Again, the QC demonstrated ACAMS 702 was operating correctly during the event. Interviews with TOCDF Monitoring Branch, personnel confirmed the QC information. (EXHIBIT L)

Monitoring Branch personnel interviewed included the shift supervisor during the event as well as the technician tending ACAMS 701A, 701B, and 701C and the QC Team leader. Their assessment is that the ACAMS were operating properly. They said that qualitatively, the peaks from the strip chart recorders were characteristically identical to the peaks expected from the chemical agent, GB. Their judgment was that the ACAMS 701A, 701B, 701C, and 702 detected GB.

Calibration and QC data were reviewed to ensure DAAMS at 701A, 701B, 701C and 702 were properly maintained and in control. DAAMS is used to confirm ACAMS alarms. DAAMS tubes from the previously listed stations were removed and taken to the CAL and analyzed for the chemical agent, GB. Prior to analyzing DAAMS tubes, Quality Laboratory (QL) standards are performed on the Mass Spectrometer (MS) and Flame Photometric Detector (FPD). In all cases, the QLs indicated the MS and FPD were in control. As a matter of course, QLs are used after sample analysis to again verify the MS and FPD are in control. Post analysis QLs indicated the MS and FPD were in control. The investigation also looked at the individual analyses of the DAAMS tubes to ensure the ion ratios were correct for the MS and the retention times were correct for the FPD. In all cases, the ion ratios and retention times were accurate for the MS and FPD, respectively, for chemical agent. GB.

Another area examined was the DAAMS tube histories. Prior to use in the TOCDF plant, the DAAMS tubes must be desorbed to ensure there is no background GB contamination.

Tube histories were examined and it was verified that the DAAMS tubes from ACAMS 701A, 701B, 701C, and 702 were desorbed prior to use in the plant. Use of a tube, which has previously been used but not properly desorbed, can incorrectly indicate the presence of chemical agent.

The shift leader on duty during the event and the QC supervisor were interviewed. The shift leader had complete confidence in the results as reported and that the DAAMS tubes analyzed did indeed have GB on them. The QC supervisor had repeatedly reviewed the DAAMS data from the event and could not find fault with the results as reported. It is their belief that the DAAMS tubes did contain agent in the amounts reported.

A monitoring technician inadvertently switched the paperwork for the DAAMS tubes from PAS 702 with the paperwork for DAAMS tubes from PAS 704. The switch occurred during the rush to get the DAAMS tubes to the Chemical Agent Laboratory (CAL) for analysis. The DAAMS tubes were transported by the technician to the CAL, put in the queue for analysis, and then analyzed. The technician realized his mistake after ten minutes. The technician immediately drove back to the CAL and informed both the personnel at the CAL and the CON of the mistake. The technician corrected and initialed the paperwork that accompanied the DAAMS tubes. A written statement, signed by the technician who switched the paperwork accompanying the tubes, is part of the archived analytical results. During the time before the mistake was corrected, the CON was not aware of the actual source of the agent released.

Perimeter monitoring stations are located at various points around TOCDF. The perimeter monitoring stations use DAAMS tubes to collect air samples that may contain chemical agent. Two tubes are used simultaneously at each station. The DAAMS tubes sample air for 12 hours and are then analyzed for chemical agents by technicians at the CAMDS), co-located with TOCDF at DCD. The perimeter DAAMS tubes sampled the air surrounding TOCDF from 1800 hours, 8 May 2000, to 0600 hours, 9 May 2000. This time frame brackets the times of the accident. One DAAMS tube from Station 905 showed a very small peak, well below the Limit of Quantification (LOQ), using FPD analysis, with a retention time consistent with that of GB. If the chromatographic peak was indeed GB, the level was approximately 0.03 of the General Population Level (GPL) (LOQ is 0.20). Results below LOQ are suspect.

A technician at CAMDS desorbed the second DAAMS tube before another confirmational analysis could be obtained. Retaining these tubes for possible analysis, even when the A (first) tube has been analyzed to below LOQ quantities, would have been beneficial.

As the second tube was not available, and to provide a more robust analysis of the DAAMS tube from station 905, meteorological data was requested from CAMDS to determine the wind speed and direction at the time of the event. The location of the eleven perimeter monitoring stations was also requested. Based on the wind speed and

wind direction, which existed at the time of this event, there was no mechanism to transport agent from the common stack to Station 905. Station 905 is located a couple of miles from TOCDF and was upwind at the time of the event. Stations in an area where the existing wind might have transported agent, 907 and 910, did not detect any GB during the event. (EXHIBIT E) This investigation concluded that no agent released from TOCDF was detected at the perimeter during the event.

In general, the ACAMS and DAAMS values are in agreement. However, some discrepancies warrant explanation. A graph titled "TOCDF ACAMS Alarms" is included (EXHIBIT G), and referred to, in the following discussion. The graph shows time, on the abscissa and the ACAMS reported level of GB on the ordinate. ACAMS 701A, 701B, 701C and 702 are shown on the graph.

The first curious result, referring to the initial alarm during the period 23:26 to 00:08 hours, is the delay in time and the depression of signal for the ACAMS 702 data, with respect to the stack ACAMS. The ACAMS 702 is upstream of the ACAMS 701 series. Normally, one would expect to find the ACAMS 702 going into alarm before or simultaneously with the ACAMS 701 series (the residence in the duct between the two detectors is on the order of seconds). However, the ACAMS 702 alarms about 14 minutes later than ACAMS 701A and 701C. Additionally, ACAMS 702 has a reported peak GB value of approximately 1.5 ASC while ACAMS 701A and 701C both have a peak value of roughly 3.5 ASC. This is unusual because the ACAMS 701A and 701C should see a lower concentration than the ACAMS 702, due to dilution downstream of 702 and upstream of 701A, 701B (which was not on-line during the first event), and 701C. The flow from ACAMS 702 was diluted prior to its arrival at ACAMS 701A, 702B, and 701C by the effluent from the liquid incinerator. This additional gas flow should reduce the ACAMS and DAAMS readings at ACAMS 701A and 701C.

The DAAMS data for ACAMS 701A and 701C correlates well with the 701A and 701C data. Likewise, the 702 DAAMS data agrees with the stack ACAMS and DAAMS data since the reported ASC value is slightly higher than 701A and 701C. This is expected because of the previously mentioned dilution of the DFS effluent with gasses from the LIC.

The second singular result is the relatively quick reduction of the reported concentration for ACAMS 701A and 701C relative to that of ACAMS 702. The ACAMS 701A and 701C go out of alarm at 2351 and 2353 hours on 8 May 2000, respectively. Meanwhile, ACAMS 702 remains in alarm until 0008 hours on 9 May 2000. Just as ACAMS 702 would be expected to go into alarm before ACAMS 701A, B. or C, it would normally be expected to go out of alarm before the stack ACAMS.

A plausible explanation of these results, consistent with the facts as they are known at this time, is carbonaceous deposits on influent side of the sample probe adsorbing and then slowly desorbing GB. Prior to the alarms, the furnace was in an upset condition.

This is known from control room data as well as ACAMS chromatographic data. The ACAMS data shows numerous compounds eluting from the gas chromatographic column where normally few if any compounds are seen. These compounds, most likely the carbonaceous Products of Incomplete Combustion (PICs), may have adhered to the inside of the ACAMS 702 sample tube thus providing attractive adsorption sites for GB entering the PAS duct sample probe. Carbon is a well-known and characterized adsorbent that adsorbs nerve agents such as GB quite well. Just as carbon adsorbs organic compounds, such as GB, it will also desorb organic compounds such as GB over time.

To check this possible explanation, the sample probes' transmission efficiencies were tested by the Monitoring Support Branch for 701A, 701B, 701C, and 702. The logbook for ACAMS 702 was also checked to see if the transmission efficiency had decreased since the event.

The logbook for ACAMS 702 showed there was a decrease in the transmission efficiency since the event. Upon getting transmissions of 20% and less, the technician, washed out the probe with deionized water. After several washings the transmission efficiency improved to an acceptable level of 80% or better. The transmissions efficiencies as tested during the investigation checked the full length of the sample probe, but the transmission efficiency is only checked on half the length or less by current procedures.

The sample probes for the ACAMS 701A and 701C, the two probes involved, were tested and found to have acceptable transmission efficiencies. Currently, the transmission efficiency is only checked on half the length or less of the sample probe.

As was noted previously, the readings for ACAMS 702 move asymptotically toward zero. This result is consistent with GB desorbing slowly from the carbonaceous deposits on the ACAMS 702 sample probe. Furthermore, with the exception of a single point, the ACAMS alarm levels rose slowly for ACAMS 702 while those of 701A and 701C rose very quickly. This is again consistent with GB adsorbing onto the carbonaceous deposits in the sample probe thus lowering the concentration of GB transmitted to the ACAMS 702.

The second event on the graph is a nearly textbook example of how the PAS ACAMS should alarm, in both time of response and level of agent, given the presence of agent in the PAS. The ACAMS 702, with its attendant sample probe, once again takes longer to go out of alarm.

C. Management/Personnel.

- 1. <u>Training Issues</u>. Control room operators undergo lengthy training to become certified. The training starts after the operator's initial employment with the systems contractor. The operators are sent to the CDTF for initial training. The operators are trained on basic system procedures and return to the site for on-the-job training (OJT). The operators are certified after a formal training program on site.
- 2. <u>Knowledge</u>. The DFS CRO was certified to operate the DFS without supervision. During his training at the CDTF, approximately one year ago, he received both written and practical examinations on furnace upset conditions. The OJT included written examinations and practical hands-on experience in operating the DFS under normal conditions, but did not include practical testing or training on furnace upset conditions. The DFS CRO had not experienced any furnace upset conditions during his OJT or during his tenure as a DFS operator. There is also no requirement to retrain CON operators at the CDTF.

Additionally, the DFS CRO did not demonstrate a thorough knowledge of the DFS system. The DFS CRO was adjusting the system to values experienced during normal operation of the furnace. The DFS CRO did not take the appropriate corrective actions based upon rapidly changing conditions. The DFS CRO used values that would have been satisfactory for normal furnace conditions. The operator was unable to determine the cause and effect relationships of the inputs he was providing. Failure to fully understand this cause and effect relationship allowed the operator to provide inputs that caused system response far exceeding normal values. The CRO was also unable to determine the entire system response based on his inputs to the control system. The operator was unaware of the conditions that caused the accident.

The acting SCRO was attempting to further the training of the DFS CRO by allowing the operator to control the furnace during a DPE entry that caused large changes in furnace pressures. This was also the first time the DFS CRO performed NNOP DFS-011-01 to clean the feed chutes. The acting SCRO was unaware that the DPE entrants placed an AQS strainer sock containing agent on the upper feed gate in the ECR. The acting SCRO believed that no agent was present in the DFS. During the initial failure of the flue gas flow meter, the acting SCRO and another senior CRO allowed the DFS operator to continue to operate the furnace believing that no agent was present.

Shift teams have varying levels of knowledge and experience. The investigation concluded that the team in the CON the night of the accident was relatively inexperienced. The experience level of the team was further degraded because the regular SCRO was on leave that night.

The DFS CRO on duty the night of the accident was relatively inexperienced at operating the DFS and had never operated the DFS after a system upset. There were only two other

members of the CON staff who were more experienced and may have been able to assist the DFS CRO recover from the DFS upset. However, one was the Entry CRO and he was fully occupied communicating with the DPE entrants during the execution of the non-normal procedure to wash debris from the DFS lower tipping valve. The other person was the acting SCRO. The acting SCRO was fully occupied with running the rest of the CON and ensuring that the plan of the day was being executed properly.

As the DFS upset progressed, the Entry CRO was able to lend some assistance. However, this assistance came too late and was not sufficient. Also, when the acting SCRO became involved and decided that this might be a good training exercise, he was not informed of the AQS strainer sock that had been placed on top of the DFS feed gate.

The investigation concluded that a lack of DFS operating expertise and poor communications in the CON contributed to the release of agent from the common stack.

3. <u>Communications</u>. During the night of the accident the Plant Shift Manager (PSM) was occupied with the coordination of the repackaging of M56 warheads in the Unpack Area (UPA) and with other administrative duties. He was unaware of the upset of the DFS and that an inexperienced CRO was being allowed to recover the system as part of his OJT. He later said that, if consulted, knowing what he knew at the time, he would have agreed with the acting SCRO and allowed the training experience to occur.

The PSM was not notified of any particular problem until he was asked to help process the Temporary Change Form, DFS-0112, to allow a jumper to be installed into the DFS BMS. The jumper was to allow the system to be purged with the intent of getting at least one AFB burner lit.

Additionally, when the PSM became involved, he was not informed of the AQS strainer sock that had been placed on top of the DFS feed gate. Had he known of the AQS strainer sock on the DFS feed gate and the excessively negative pressures in the kiln, he may have directed the acting SCRO to ensure that the DFS was bottled-up until an alternate restart method could be developed.

The investigation concluded that poor communications in the control room and the resulting lack of early awareness by the PSM contributed to the release of agent from the common stack.

D. Observations.

1. <u>DPE Entry</u>. A pre-entry meeting precedes every DPE entry conducted at TOCDF. This meeting must be attended by the PSM (or designee). It must also be attended by the operations supervisor, the DPE entrant team, the DPE Support Area (DSA) lead operator and support team, a safety representative, the CON operator involved, the Medical Clinic person who will monitor the entry, and an environmental representative. During this

meeting, the qualifications of involved personnel are verified, the tasks to be accomplished are discussed, and entry/exit routes are identified using the pre-entry checklist. The pre-entry checklist (EXHIBIT J) has not implemented PMCD Policy Statement No. 57, Medical Evaluations for Potential Exposure at Chemical Demilitarization Facilities (CDF) and the CAMDS – Department of Army Pamphlets (DA PAMs) 40-8 and 40-173. dated 29 December 1998. The area which has not been implemented relates to the agent level in the surrounding air if the DPE should be breached, and so did not figure into the events of 8-9 May 2000 in any way, but the checklist criteria should be made consistent with PMCD policy.

The videotape of a DPE entry to ECR B was reviewed. All DPE entries are video taped for accident prevention purposes and systems analysis. This videotape documents the operation to free a lower tipping valve, which had been sticking on 8 May 2000 (although the entrants state the debris was actually clear by the time they arrived at the ECR). The actions observed correspond with the entrants' description, especially the multiple times they had to return to the airlock to obtain supplies (a ball valve, a hose clamp, a drop light). This resulted in the tipping valve being cycled numerous times. It is noted, however, that the time stamp on this videotape is incorrect by several hours. While the entry actually began around 2010 hours, the time stamp on the videotape indicates it began at approximately 1420 hours.

- 2. Read & Sign. All TOCDF SOPs require personnel to read and sign a document indicating they have read and understand the requirements of each SOP. A "Read and Sign" document is also required for all changes to SOPs. A sample of "Read and Sign" documents was reviewed to determine if this requirement was being implemented. Based on this sample, the requirement is being fulfilled. As a side note, TE-SOP-004 Rev 4 Chg I was approved on 17 April 2000, but the basic document, TE-SOP-004 Rev 4 Chg 0, was not approved until 26 April 2000. (EXHIBIT Q) While the actual change was very minor, it is nonetheless troubling that a change was somehow approved for implementation before the basic document had been accepted for use.
- 3. Training. The Personnel Training Plan (PTP), Revision 5, (CDRL 18) was reviewed. This document identifies the training requirements for certification and qualification of all personnel. The personnel training records for the identified personnel meet the requirements of the PTP. However, the training records are not standardized in their description. Over time, course material has been redistributed among courses. All material is still being taught, but course names have changed in some instances. For instance, the Site CSDP Ammunition Course (SAMMO) is a required course for all CON operators. However, not all CON operators have taken this class. The reasoning for this is that the more senior personnel are listed as taking General Employee Training. This course, which is no longer offered, included the information currently provided by SAMMO. Although the PTP requires all CON operators to take the Container Handling

Building (CHB) Operators Class, some CON operators have not taken this course. This course is currently only provided to those CON operators who are/will be CHB operators. The PTP does not reflect these changes to course names and training philosophy.

III. FINDINGS AND RECOMMENDATIONS

A. Mechanical Systems Analysis

Finding #1. If the flue gas flow meter had not failed, the DFS CRO would have been able to stabilize DFS flows and pressures. It is probable that the DFS CRO would have been able to return the DFS to its normal operating parameters and been able to process the contaminated AQS strainer sock safely. If the flue gas flow meter had not failed, there would have been no release of chemical agent from the common stack. (EXHIBIT A/M)

Finding #2. If the flue gas flow meter had not been exposed to excessive amounts of liquid, it would not have failed. If the flue gas flow meter had not failed, the DFS CRO would have been able to stabilize DFS flows and pressures. It is probable that the DFS CRO would have been able to return the DFS to its normal operating parameters and been able to process the contaminated AQS strainer sock safely. If the flue gas flow meter had not failed, there would have been no release of chemical agent from the common stack. (EXHIBIT A/M)

Finding #3. It is probable that if the flue gas flow meter had not erroneously indicated a loss of system flow, the DFS CRO would have been able to stabilize DFS flows and pressures and been able to process the contaminated AQS strainer sock safely. If the flue gas flow meter had not indicated erroneously, there would have been no release of chemical agent from the common stack. (EXHIBIT A/M)

Recommendation #1-3. Identify and install a more robust method of ensuring that the DFS flue gas rate is measured for minimum draft. The following options should be investigated:

- Install a backup to 24-FSLL-430 using a more robust flow-indicating switch. Wire the signal from this switch into the BMS in parallel with the existing 24-FSLL-430.
- Identify a flow element and flow-indicating transmitter that is more robust and resistant to exposure to the flue gas at the exhaust of the scrubber tower under all DFS operating conditions.
- Determine if there is an alternate location that the flow element can be installed so that it can perform its intended function without being exposed to conditions that cause degraded performance.

Assigned to: PMCSD

Finding #4. The current configuration of the BMS forced the operator to purge the furnace and introduced cold air into the furnace system. The furnace did not require a purge prior to relight. (EXHIBIT A/P)

Recommendation #4. Evaluate the BMS design, to allow a relight of the furnace if the temperature is above 1400°F and a flow is established.

Assigned to: PMCSD

Finding #5. If the DFS AFB could be isolated from the kiln remotely by the DFS CRO in the CON in a timely manner, then it is probable that the DFS CRO would have done so. If the DFS AFB had been isolated from the kiln during the attempts to troubleshoot the flue gas flow meter and relight one burner in the DFS AFB, there would have been no release of chemical agent from the common stack. (EXHIBIT K)

Recommendation #5. Incorporate ECP TEAC505JLL to install an isolation system that would allow the CON to remotely isolate the AFB from the kiln during upset conditions. This design would be consistent with the other three baseline CONUS sites (Pine Bluff, Umatilla, and Anniston Chemical Agent Disposal Facilities).

Assigned to: TOCDF Field Office

Finding #6. PLC automatic system response to a loss of DFS purge contributed to the difficulties during the recovery of the DFS upset. (EXHIBIT A/M/P)

Recommendation #6. Modify the response of the control system so that an operator action is required in order to configure the DFS to initiate system purge.

Assigned to: PMCSD

Finding #7. The automatic response of the control system distracted the DFS CRO from performing other recovery procedures. If the DFS CRO had not controlled 16-TIC-092 CV manually and reduced the CV from 100% to 10%, the automatic response of 16-TIC-092 would have contributed to the DFS system upset. (EXHIBIT A/M/P)

Recommendation #7. Modify the response of the control system so the 16-TIC-092 CV is set to zero whenever neither AFB burner is lit. Modify the response of the control system so that when either AFB burner is first relit, 16-TIC-092 gradually controls the AFB temperature from the temperature at the time the burner is lit to the temperature SP.

Assigned to: PMCSD

Finding #8. Common stack and duct exhaust gas sampling probes are subject to contamination, which was not detected under current inspection procedures.

Recommendation #8. The entire length of Stack/PAS Duct sampling probes should be tested at least weekly to verify agent transfer capability.

Assigned to: PMCSD

Finding #9. The high velocity of the flue gases decreased the agent destruction efficiency. The high velocity of the flue gases contributed to the release of chemical agent out of the common stack. (EXHIBIT P)

Recommendation #9. Provide a method for the CRO to be able to monitor the DFS/DFS PAS as a single system so that flow and pressure excursions can be more readily identified and corrected. Possible solution would be the development of a single Advisor screen that contains all of the necessary pressures, temperatures and flows for the DFS/DFS PAS.

Assigned to: PMCSD

B. Operations/Procedures

Finding #10. NNOPs, prepared in accordance with Non-Normal Procedure Development. Revision and Deletion, Revision 0, Change 2, 2 September 1999 (PRP-MG-010), do not fully address the requirements of operating procedures or provide the necessary detail. (AR 385-61, paragraph 2.4.e, DA Pam 385-61, paragraph 6.3.a, and PMCD-R 385-1, paragraph 8.) (EXHIBIT H/I)

Recommendation #10. Revise the Non-Normal Procedure Process (PRP-MG-010) to assure that these procedures fulfill the essential elements of an operating procedure in accordance with AR/DA Pam 385-61, DA Pam 385-64, and PMCD-R 385-1, to include a complete and accurate hazards analysis.

Assigned to: TOCDF Field Office

Finding #11. The hazard analysis for Non-Normal Procedures, prepared in accordance with PRP-MG-010, did not completely and accurately assess the risk of the operation to assure appropriate mitigation. (EXHIBIT H/I)

Recommendation #11. Assure that procedures are not applied to operations beyond the original intent or the scope of the supporting hazard analysis.

Assigned to: TOCDF Field Office

Finding #12. The Non-Normal Procedure being implemented to clean the DFS ECR-B feed chute the evening of 8 May 2000 (DFS-011-01) had not been prepared for that specific operation. (EXHIBIT H)

The DFS feed chute cleaning operation being conducted the night of 8 May 2000 had been performed on a recurrent basis (at least twice in the previous three months).

Recommendation #12. Cleanout procedures for DFS feed chutes should be formally prepared as an appropriately detailed, validated standalone procedure or incorporated into an existing procedure. The procedures should incorporate all essential elements of AR/DA Pam 385-61, DA Pam 385-64, and PMCD-R 385-1 with a thorough hazard analysis conducted in accordance with PMCD-R 385-1 and individuals who will perform the operations trained.

Assigned to: TOCDF Field Office

Finding #13. The organization of TE-SOP-004 required the CRO to hunt through the document to find those sections appropriate for the on-going situation. (EXHIBIT M)

Recommendation #13. The format/organization of SOPs used in the Control Room (CON) should be reassessed to assure critical information is presented in a readily accessible timely manner, in accordance with PMCD-R 385-1, paragraph 8.

Assigned to: TOCDF Field Office

Finding #14. Procedures at CAMDS authorized the B (backup) DAAMS sampling tube to be desorbed without analysis whenever the A tube was determined not to have detected agent above the LOQ. (EXHIBIT M)

Recommendation #14. Procedures should be established to assure that B tubes from DAAMS perimeter monitoring stations are retained for later analysis if the results of the A tube indicate a peak within the agent gate, but less than the instrument's LOQ.

Assigned to: CAMDS/PMCD

Finding #15. TE-SOP-004 R4,C0 (DFS Operations) was approved 26 April 2000; TE-SOP-004 R4,C1 had been approved 17 April 2000. A change to a Standing Operating Procedure was approved before the basic document was approved. (EXHIBIT Q)

Recommendation #15. Reassess the process by which procedures are reviewed/ approved, with specific attention to the sequence in which changes are approved/ incorporated.

Assigned to: TOCDF Field Office

Finding #16. The DFS operating procedure TE-SOP-004, does not address the situation in which a hot relight of the DFS AFB may be required. The DFS CRO was required to follow the normal restart procedures during the accident. (EXHIBIT M/O)

Recommendation #16. The SOP should be changed to allow the DFS CRO to perform a restart of the DFS when the furnace has flow and temperature in accordance with National Fire Protection Association Standards. The SOP should also contain enough detail to assist the CRO during upset conditions.

Assigned to: TOCDF Field Office

Finding #17. The PAS is designed to remove acid gases from incinerator exhaust and is not designed or intended to destroy chemical agent; however, the alkalinity of the solution will react with GB, if present. If the clean liquor flow had not been stopped, the agent in the DFS flue gas flow system would have had increased contact time with the caustic in the clean liquor solution. If the clean liquor pump had remained running, the total amount of agent released from the common stack would have been reduced. (EXHIBIT A/P)

Recommendation #17. Ensure, by procedure, that clean liquor and quench brine flow is established whenever the ID fan or emergency ID fan is running. The Programmatic Lessons Learned Issue 96-662 identified the issue of ensuring that the clean liquor pump was operating when the induced draft fan is operating.

Assigned to: PMCSD

Finding #18. An excessive amount of water was added to the DFS feed chute. This water flashed to steam when it entered the high temperature environment of the kiln. This rapid generation of steam instantly upset the temperature – pressure relationship and contributed to the perturbations of the DFS pressures and flow rates. (EXHIBIT P)

Recommendation #18. Modify chute cleaning procedure to eliminate excess water.

Assigned to: TOCDF Field Office

Finding #19. The inability of the DFS CRO to maintain DFS pressures adequately after the execution of NNOP DFS 0112 to clean debris from the DFS tipping valve was a contributing factor to the release of chemical agent out of the common stack. (EXHIBIT A/P)

Recommendation #19. Provide the necessary troubleshooting skills by training all furnace operators in the proper techniques for using both the ID fan inlet damper and the venturi plug valve to control system flow and pressure after a furnace upset.

Assigned to: PMCSD

Finding #20. The amount of time required to obtain approval of a temporary change during an upset is excessive. During the night of the accident, the temporary change to bypass the flue gas flow meter required over 30 minutes. (EXHIBIT M/S)

Recommendation #20. The temporary change procedure should be reviewed to ensure it is responsive to the operators' needs. People required to sign indicating approval of the temporary change should be available on site 24 hours a day. Common and routine temporary changes should be incorporated into a procedure.

Assigned to: TOCDF Field Office

Finding #21. The CROs are using uncontrolled drawings at their workstations. Controlled drawings can not be reproduced for use in operating the plant as per Review and Distribution of Documents (PRP-DC-008). (EXHIBIT M)

Recommendation #21. The drawings required by the CROs should be controlled under the Receipt and Storage of Records and Reference Documents (PRP-DC-004). The drawings should be stored at the CRO's workstation and should only be those drawings that pertain to the CROs specific operation.

Assigned to: TOCDF Field Office

C. Management/Personnel/Training

Finding #22. The lack of overall system knowledge and experience of the shift on duty the night of the accident contributed to the release of chemical agent out of the common stack. (EXHIBIT M)

Recommendation #22. Periodically review the experience level of the four shift teams. Reassign the workforce to ensure that each shift is equally qualified to safely operate the TOCDF.

Assigned to: TOCDF Field Office

Finding #23. The certification process for CON operators does not include refresher training. During the accident, the ability of the control room operator to react to a dynamic situation was degraded by the lack of experience. The experience in controlling any of the furnaces during an upset condition is accomplished during their initial training at the CDTF. (EXHIBIT M)

Recommendation #23. The normal certification process for a CON operator starts with some initial training at the CDTF. This training provides the operator with a basic set of skills required to operate the systems he/she is expected to operate. During the training at

the CDTF, the operator is tested on his ability to handle a variety of system conditions, to include system upset. After this training, the operator is sent to the site for on the job training. The on-site training can not provide the contingency training required to maintain proficiency should an upset occur.

To maintain operator proficiency in contingency training, a PC based simulator should be installed on site. The simulator training could be incorporated and managed under the current on-site training program. The training should be accomplished on a frequent enough basis to allow operators to maintain proficiency in contingency operations. The training may be self-paced or facilitated.

Assigned to: PMCSD

Finding #24. The DFS CRO did not demonstrate a detailed working knowledge of the DFS. This was demonstrated by his inability to control the two devices used to maintain furnace pressure within tolerance. (EXHIBIT A/P)

Recommendation #24. The DFS CRO had not been tested on his working knowledge of the DFS for about one year. The operator had completed his required training and was not required to attend any further training. The TOCDF should consider formal training on site or refresher training at the CDTF. This training should be adaptable to the requirements of the individual receiving the training.

Assigned to: TOCDF Field Office

Finding #25. A lack of DFS operating expertise and poor communications in the control room contributed to the release of agent from the common stack. (EXHIBIT M)

Poor communications in the CON and the resulting lack of early awareness by the Plant Shift Manager contributed to the release of agent from the common stack.

Recommendation #25. Routinely provide team building and communications skills training to the CON crews.

Ensure that the Plant Shift Manager has the necessary skills and knowledge to identify and troubleshoot overall plant system upsets.

Assigned to: TOCDF Field Office

D. Observations

Observation #1. During the DPE entry to ECR B, 8 May 2000, an entrant's air hose was allowed to lie directly above the hot upper feed gate, which could compromise the material.

Recommendation #1. Procedures should be established to assure that DPE airlines are not routed across the DFS upper feed gate.

Observation #2. TOCDF has not implemented PMCD Policy Statement 57, Medical Evaluations for Potential Exposure at Chemical Demilitarization Facilities (CDF) and the Chemical Agent Munitions Disposal System (CAMDS) – Department of Army Pamphlets (DA PAMs) 40-8 and 40-173, dated 29 December 1998. (EXHIBIT J)

Recommendation #2. PMCD Policy Statement 57, dated 29 December 1998, should be fully implemented at TOCDF.

Observation #3. The time stamp on the videotape documenting the DPE entry conducted beginning approximately 2010 hours, 8 May 2000, is incorrect by about five hours; the time stamp shows times beginning about 1420 hours. These videos are useful for training, accident investigation/prevention, system analysis, etc.; the confusion caused by mislabeling degrades their usefulness.

Recommendation #3. Videotape recorders in the CON should be frequently tested to assure the date stamp being applied is accurate.

Observation #4. The Personnel Training Plan does not accurately reflect the training needs of all personnel.

Recommendation #4 Revise the PTP to accurately reflect required training for all positions.

GLOSSARY

Term	Definition
ACAMS	Automatic Continuous Air Monitoring System (based on gas
!	chromatography)
AFB	Afterburner – The secondary chamber of a CSDP incinerator; the exhaust
	from the primary chamber is further exposed to high temperature to
i I	assure agent destruction
AQS	Agent Quantification System
AR	Army Regulation
ASC	Allowable Stack Concentration – for GB. 0.0003 mg/m ³
BMS	Burner Management System
CAL	Chemical Agent Laboratory
CAMDS	! Chemical Agent Munitions Disposal System
CCTV	: Closed Circuit Television
CDC	Centers for Disease and Prevention
CDTF	Chemical Demilitarization Training Facility
CHB	Container Handling Building
CON	Control Room
CONUS	Continental United States
CRO	Control Room Operator
CSDP	Chemical Stockpile Disposal Project
CV	Control Variable; a signal to a control device (e.g. how far open/closed)
D2PC	Downwind Hazard Prediction Modeling Program
DAAMS	Depot Area Air Monitoring System (based on gas chromatography in the lab)
DA Pam	Department of Army Pamphlet
DCD	Deseret Chemical Depot
DFS	Deactivation Furnace System (destroys explosive components of munitions & residual agent; thermally decontaminates metal parts of rockets & mines)
DPE	Demilitarization Protective Ensemble (fully encapsulating suit. supplied air)
DSA	DPE Support Area
ECP	Engineering Change Proposal
ECR	Explosive Containment Room (room where explosive components are
1 1 1	disassembled: built to contain the effects of an explosion)
FPD	Flame Photometric Detector
GB	Isopropyl Methylphosphonofluoridate (Nerve Agent)
GP	General Physics Corporation
GPL	General Population Level
HDC	Heated Discharge Conveyor
ID Fan	Induced Draft Fan

GLOSSARY (Cont'd)

Term	Definition
SOP	Standing Operating Procedure
SP	Set Point
TOCDF	Tooele Chemical Agent Disposal Facility
UMC	Upper Munitions Corridor
UPA	Unpack Area
U.S.	United States
USANCA	U.S. Army Nuclear and Chemical Agency
USATCES	U.S. Army Technical Center for Explosives Safety
WC	Water Column - inches of water column is a pressure measurement (the
<u> </u>	force required to raise a column of water one inch)